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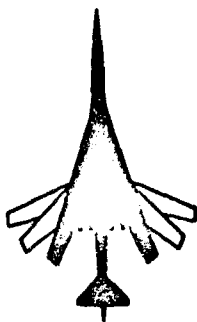
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PROPULSION SYSTEM
PERFORMANCE SPECIFICATION
PRATT & WHITNEY AIRCRAFT
JTF 17A-20B ENGINE INSTALLATION

COMMERCIAL
SUPERSONIC TRANSPORT
PROGRAM

PHASE II-C
INTERIM AIRCRAFT PERFORMANCE
ASSESSMENT REPORT

NOVEMBER 15, 1965
CONTRACT -FA-55-66-5

THE **BOEING** COMPANY
RENTON, WASHINGTON, U.S.A.

D6-19906-2

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FAA SECURITY CONTROL
NO. 67229 A-2

ISSUE No. **8**

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1.0 SCOPE

This specification defines the installed performance of the 650-pound-per-second Pratt & Whitney JTF17A-20B engine in the Boeing Model 733-394 airplane. Performance data are presented for the initial service (1900°F) engine and the basic (2200°F) engine. The estimated inlet drag values used for the determination of airplane performance characteristics are also specified.

System performance requirements established herein are design objectives to be applied to the prototype airplanes. Application of these requirements to production airplane design will be established after prototype flight testing.

2.0 APPLICABLE DOCUMENTS

The following documents are to be used in conjunction with this specification:

Pratt & Whitney Specification 2681 -
Engine Model JTF17A-20B, October 30, 1964,
Revised November 1, 1965

Pratt & Whitney Engine Performance Data
Decks 5173 Low TIT and 5172 High TIT,
September 15, 1965

The documents listed below are Boeing publications:

D6-19907	Power Plant Installation Performance Specification
D6-19909	Air Induction System Performance Specification
D6-19905	Air Induction System Performance Specification
D6-19908	Propulsion Control System Performance Specification.

3.0 PROPULSION SYSTEM DESCRIPTION

3.1 ENGINE

The P&W JTF17A-20B engine is a twin-spool, axial-flow, turbo-fan engine incorporating a full-length fan duct with duct heater, a variable-geometry nozzle for the fan duct, a blow-in-door, convergent-divergent ejector nozzle, and a thrust reverser. A detailed engine description with special features required for installation is contained in the Pratt & Whitney Model Specification. The airplane engine installation is described in Boeing Document D6-19907, Power Plant Installation Performance Specification.

3.2 PROPULSION POD

The propulsion pod incorporates a variable centerbody air induction system, an unpressurized nacelle, remotely mounted aircraft accessories, and an exhaust nozzle system with thrust reverser. The air induction system is described in Boeing Document D6-19909, Air Induction System Performance Specification.

3.3 CONTROL

Installed performance is based on air induction control system and engine control system described in Boeing Documents D6-19905, Air Induction Control System Performance Specification and D6-19908, Propulsion Control System Performance Specification, respectively.

4.0 INSTALLED ENGINE PERFORMANCE

4.1 CALCULATION PROCEDURE

The installed engine performance is calculated by the use of Pratt & Whitney Performance Data Deck (see Section 2.0). The data deck is capable of accurate calculation of engine performance, including the installed effects of inlet recover, nozzle coefficient, and bleed and power extraction, within engine limits. For the performance calculations the low airflow schedule was used.

a. Performance Assumptions

The engine performance determination was made under the following assumptions:

- Atmosphere: Performance is based on U.S. Standard Atmosphere, 1962 - Geometric Altitude.
- Fuel: Performance is based on fuel specification ASTM D1655 Jet A or A-1 Type Aviation kerosene, conforming to Pratt & Whitney Fuel Specification PWA 533, with a lower heating value of 18,500 Btu per pound.

b. Inlet Total Pressure Recovery

The inlet total pressure recovery used to calculate installed engine performance is shown in Fig. 1.

c. Nozzle Coefficient

The nozzle thrust coefficient used to calculate installed engine performance is shown in Fig. 2. External boattail drag is included in this thrust coefficient. The nozzle thrust coefficients

are based on a secondary corrected cooling flow $\left(\frac{W_s}{W_p} \sqrt{\frac{T_s}{T_p}} \right)$

equal to 3 percent for duct-heater temperatures above 2750°R and a secondary corrected cooling flow of 2 percent for duct heater temperatures below 2750°R. The ram drag of the secondary air is included in the thrust coefficients shown on Fig. 2.

d. Horsepower Extraction

Table A lists the horsepower extracted from the engine for various flight conditions to supply power for aircraft systems.

e. Engine Airbleed

Table A lists the airbleed extracted from the high-pressure compressor for various flight conditions to supply high-pressure air for aircraft systems.

JTF17A-208-1900°F/2000°F RATING

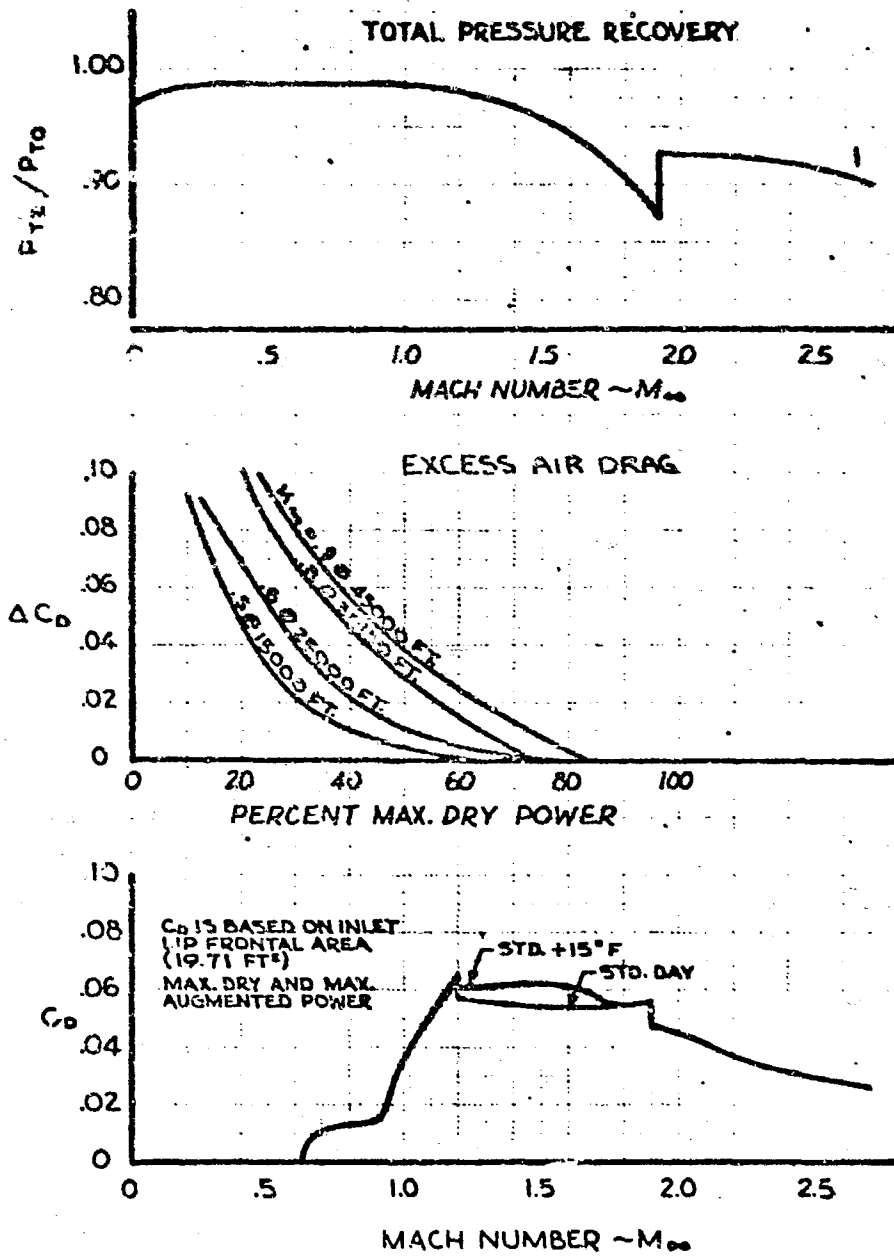


Fig. 1 Installed Inlet Drag Coefficients and Inlet Ram Recovery

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JTF 17A-20B ~ 1900°F / 2000°F RATING

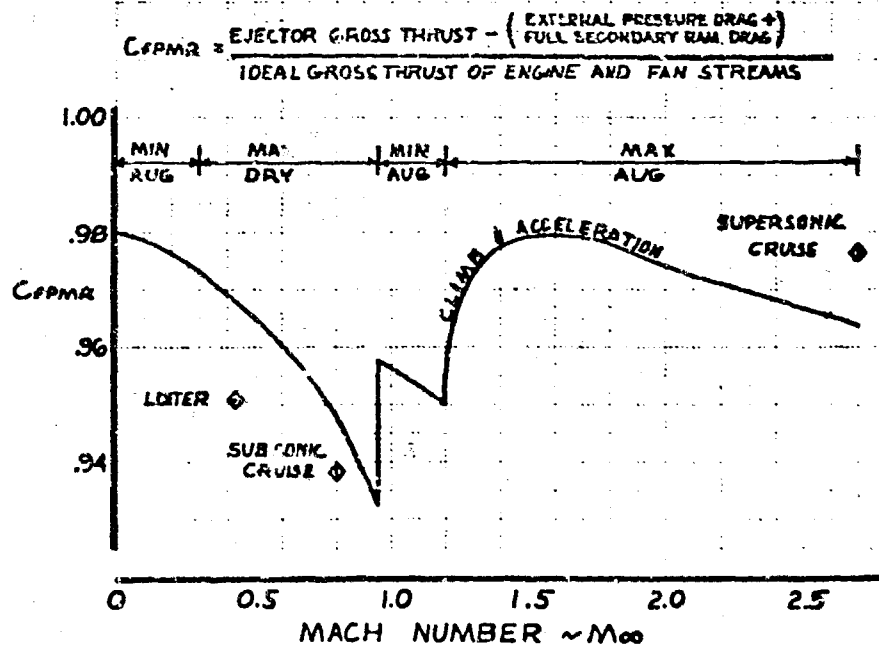


Fig. 2 Thrust Coefficient

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Table A Horsepower and Bleed Air Extractions

Airplane Operating Condition	Horsepower Extraction per Engine	Bleed Air (pounds per second per engine)	
		Compressor	Inlet
Takeoff	325	--	1.6
Climb and Acceleration	350	--	1.6
Supersonic Cruise	300	--	1.3
Holding at Mach 0.4, 15,000 feet	300	--	2.8
Cruise to Alternate at Mach 0.8, 36,150 feet	300	--	2.8
Descent	250	1.4	1.2

f. Engine Operating Envelope

The standard-day operating envelope for the engine is shown in Fig. 3.

4.2 ENGINE PERFORMANCE CURVES (1900°F)

Installed-engine performance curves for the initial service (1900°F) engine for standard and nonstandard day are shown on Figs. 4 through 16.

JTF 17A-20B

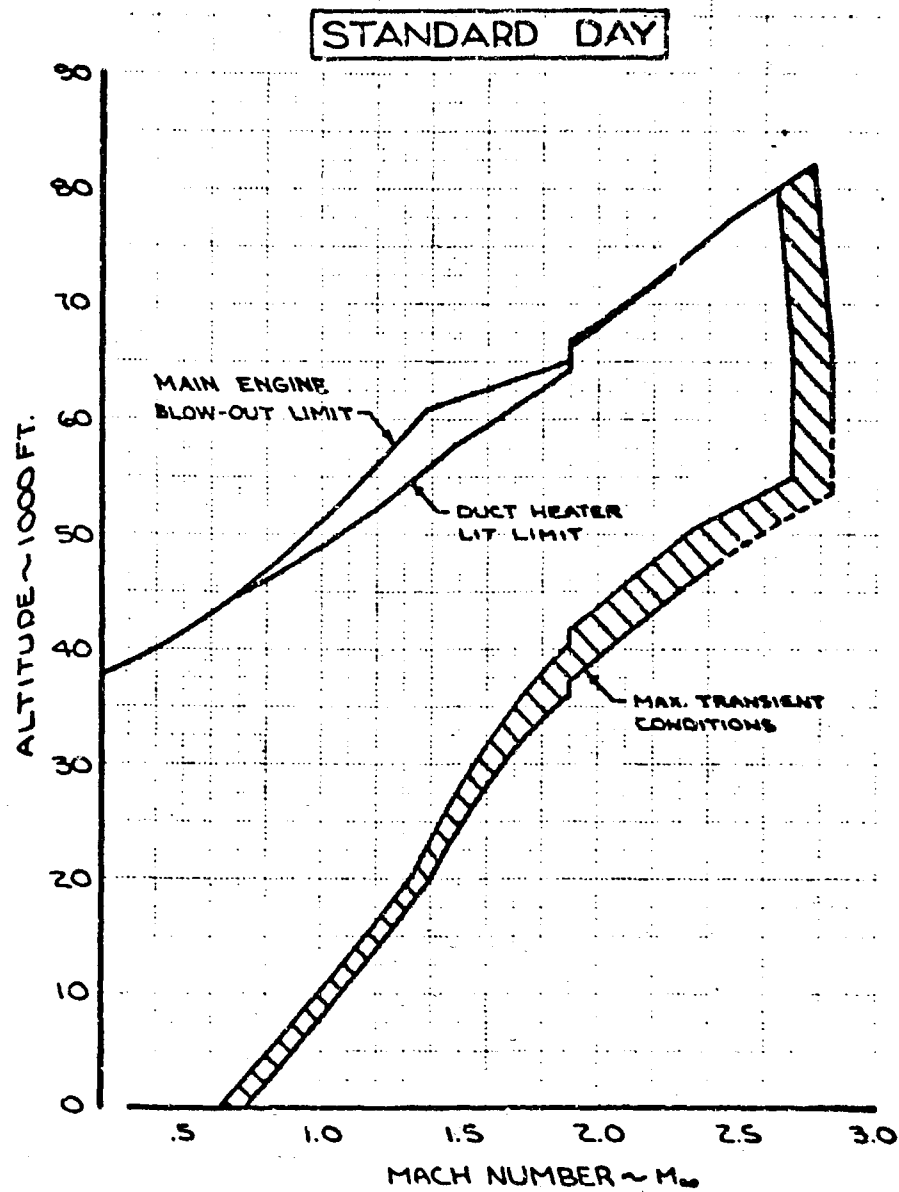
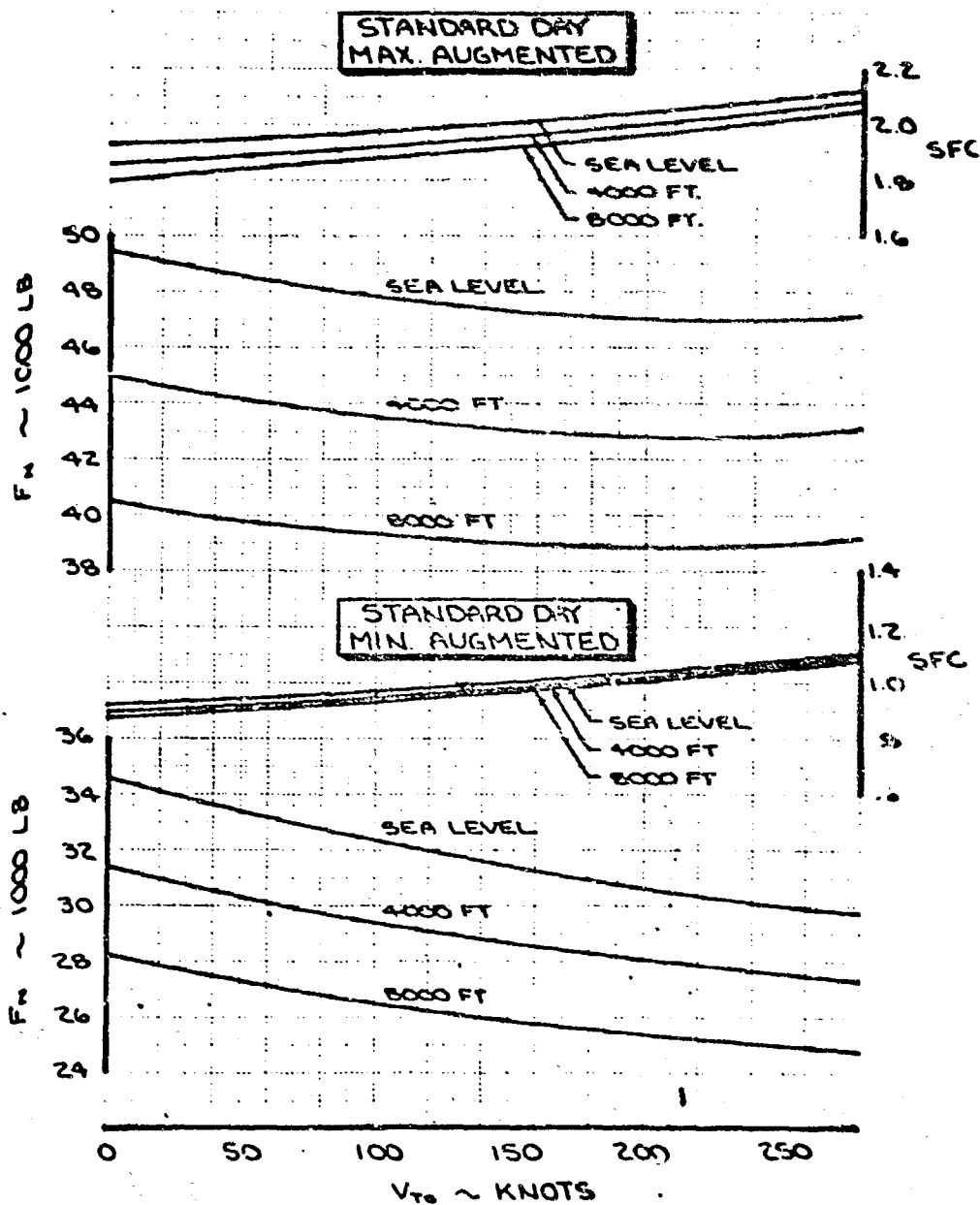


Fig. 3 Engine Operating Envelope

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JTF 17A-20B ~1900°F/2000°F RATING



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JTF 17A-20B-1900°F/2000°F RATING

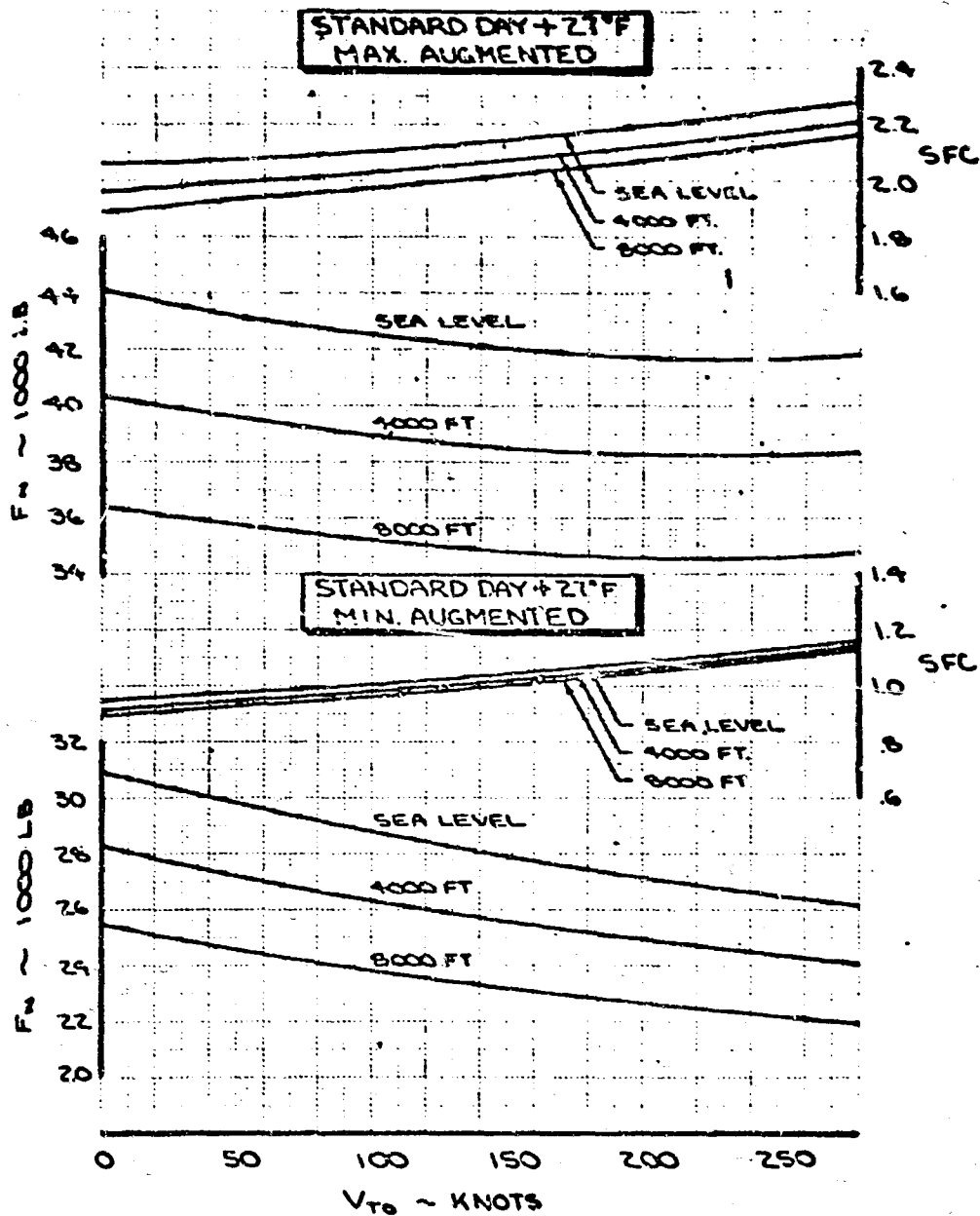


Fig. 5 Takeoff Net Thrust and SFC - Standard Day + 27°F

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JTF 17A-208-1500°F/2000°F RATING

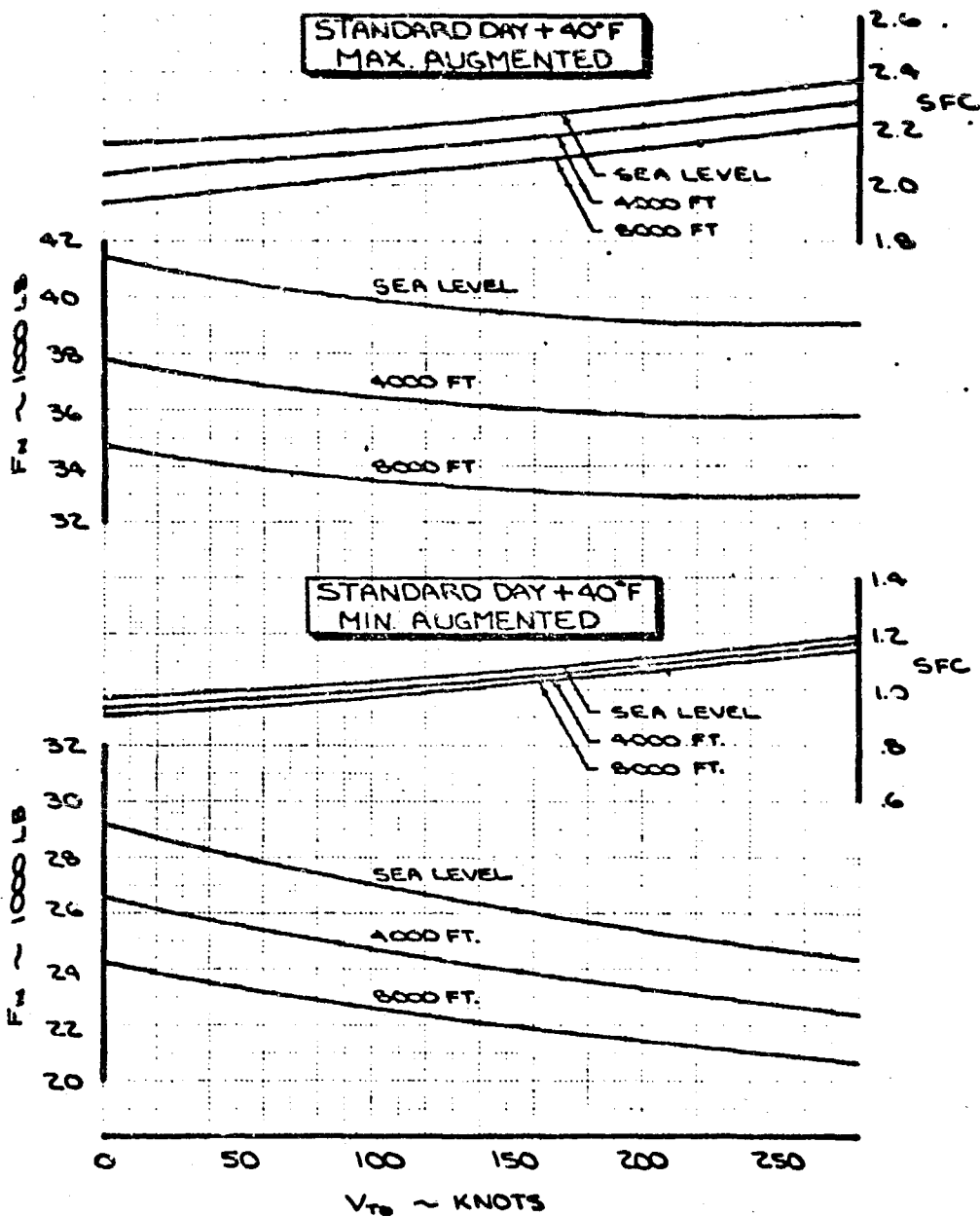


Fig. 6 Takeoff Net Thrust and SFC - Standard Day + 40°F

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JTF 17A-208 ~ 1500°F / 2000°F RATING

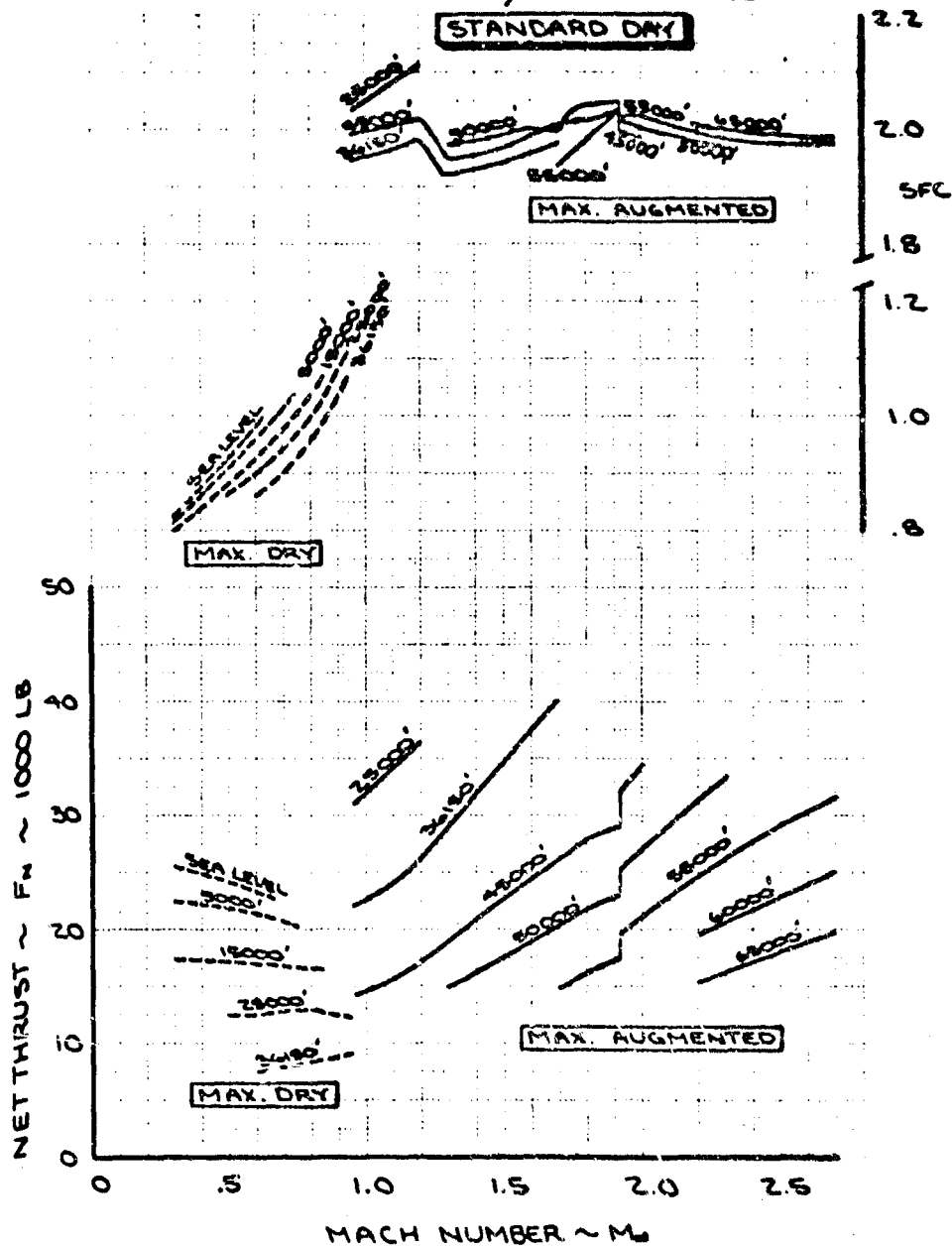


Fig. 7 Climb and Acceleration Net Thrust and SFC - Standard Day

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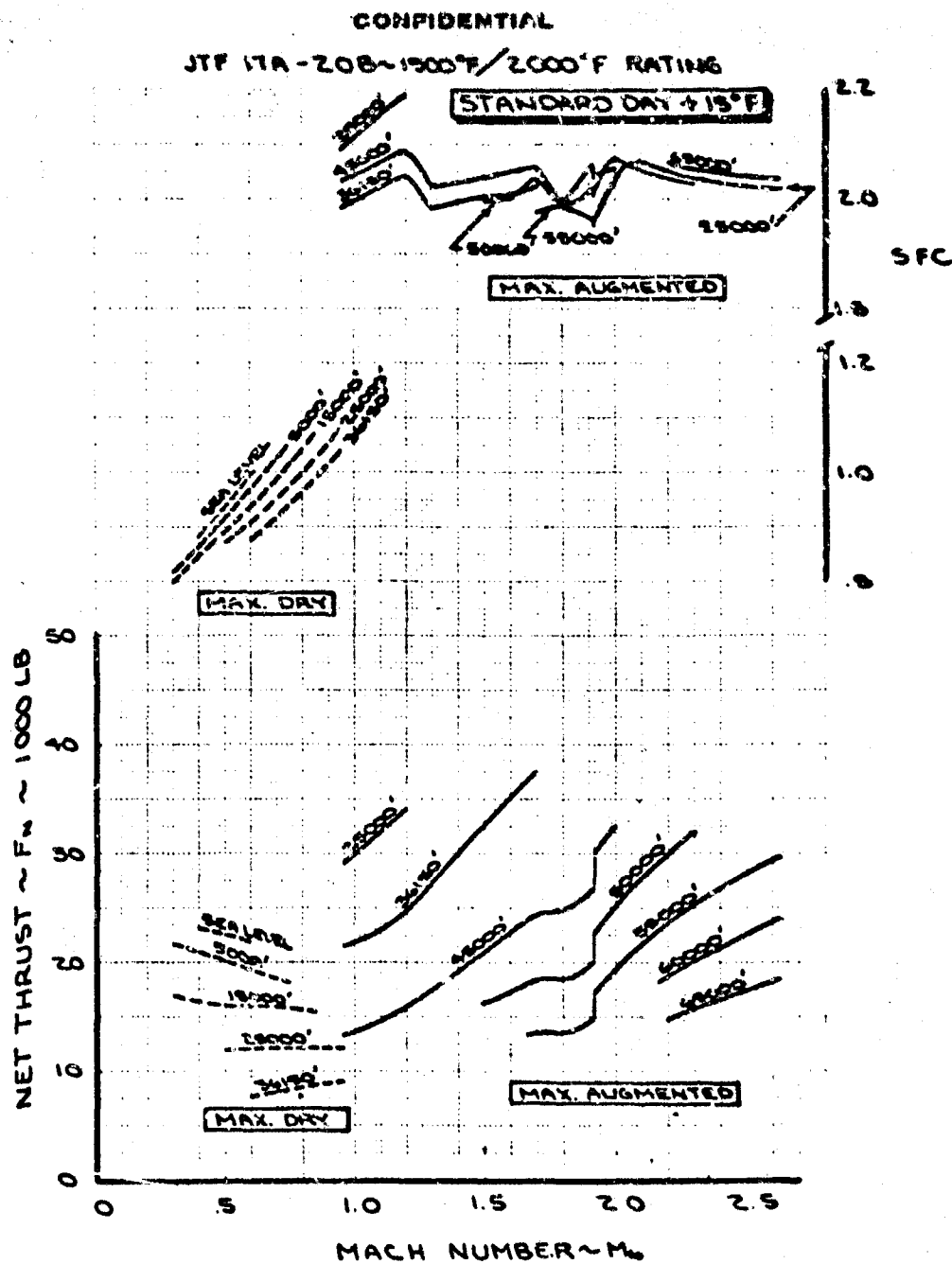


Fig. 8 Climb and Acceleration Net Thrust and SFC Standard Day + 15°F

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JTF 17A - 20B-1900°F/2000°F RATING

MACH 2.1 CRUISE
STANDARD DAY
T₂ LIMIT 500°F

AUGMENTED

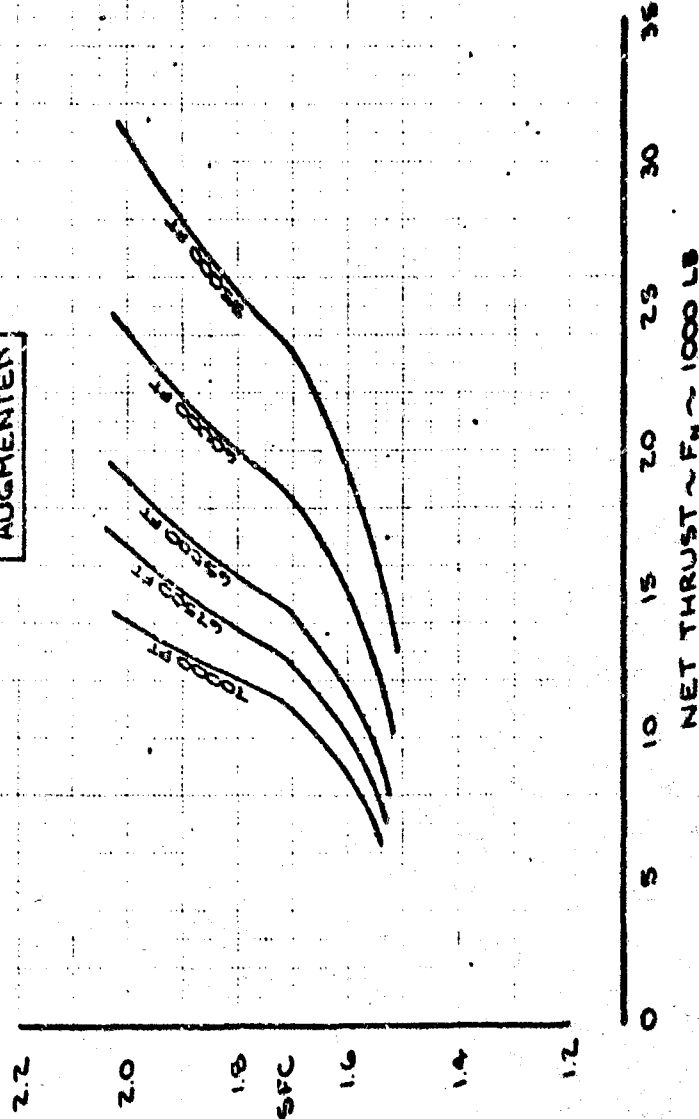


Fig. 9 Cruise No. Thrust and SFC - Standard Day

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JTF 17A-Z08 ~ 1300F / 2000°F RATING

MACH 2.63 CRUISE
STANDARD DAY + 15°F
T_W LIMIT = 500°F

AUGMENTED

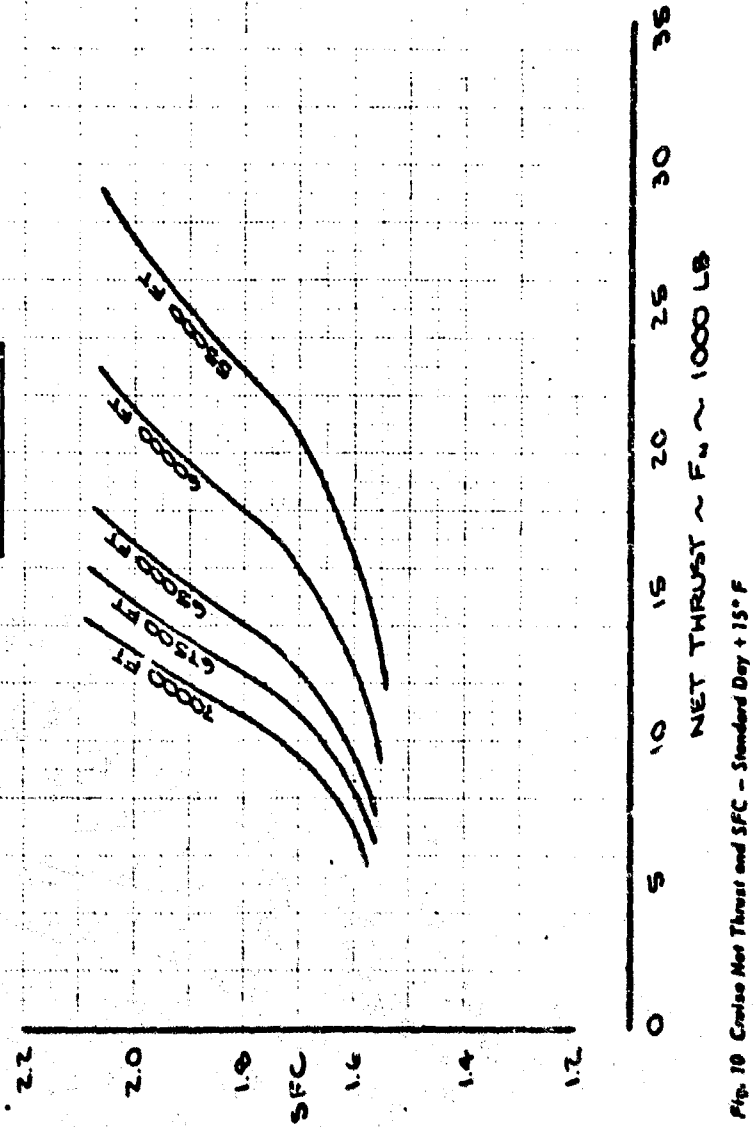


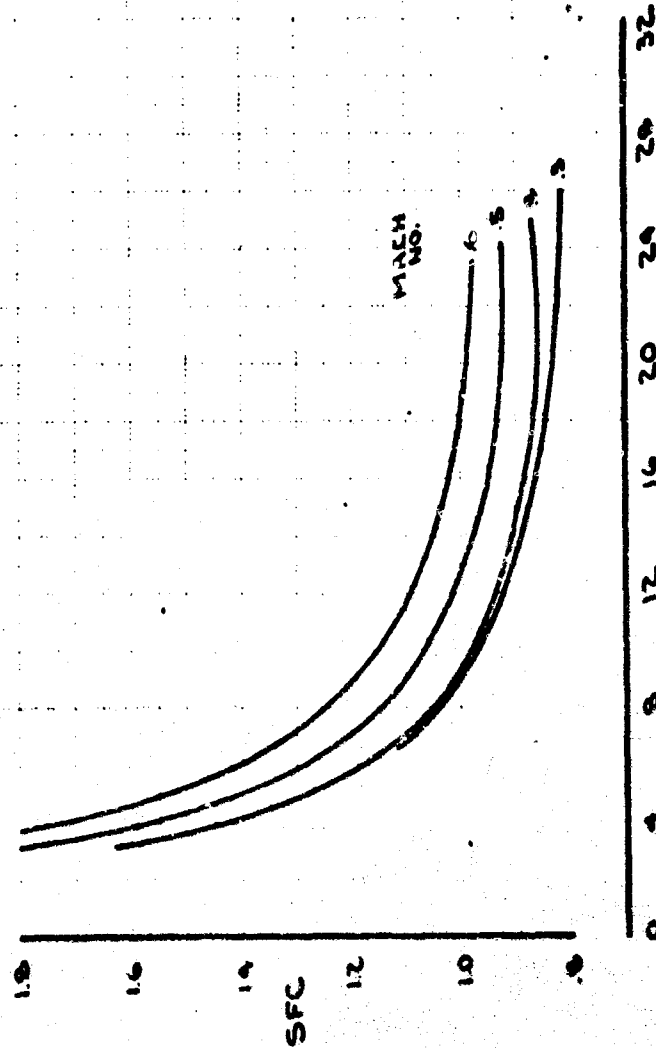
Fig. 10 Cruise Net Thrust and SFC - Standard Day + 15°F

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JTF 17A - 20B - 1900°F / 2000°F RATING

STANDARD DAY
SEA LEVEL



NET THRUST. ~ F_W ~ 1000 LB

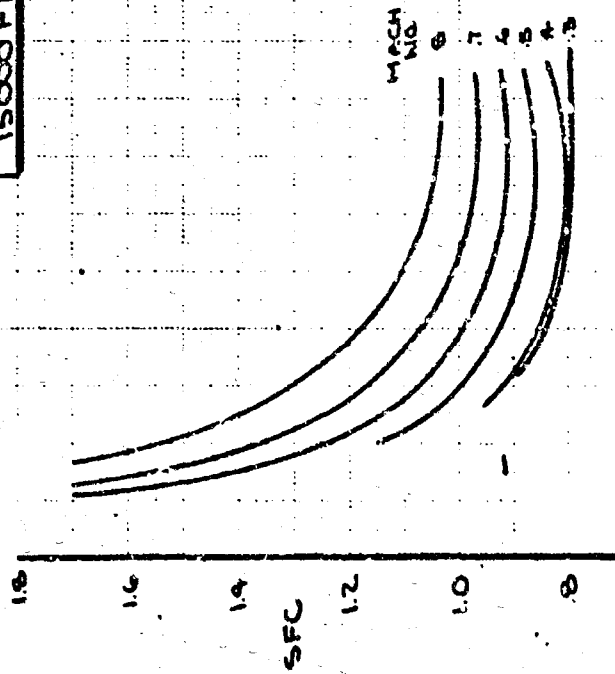
Fig. 11 SFC versus Thrust - Standard Day, Sea Level

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JTF 17A-20B ~ 1900°F / 2000°F RATING

STANDARD DAY
15000 FT.



0 4 8 12 16 20 24 28 32

NET THRUST ~ F_N ~ 1000 LB

Fig. 12 SFC versus Thrust - Standard Day, 15,000 Ft.

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JTF ITA - 20B - 1900°F/2000°F RATING

STANDARD DAY
25,000 FT

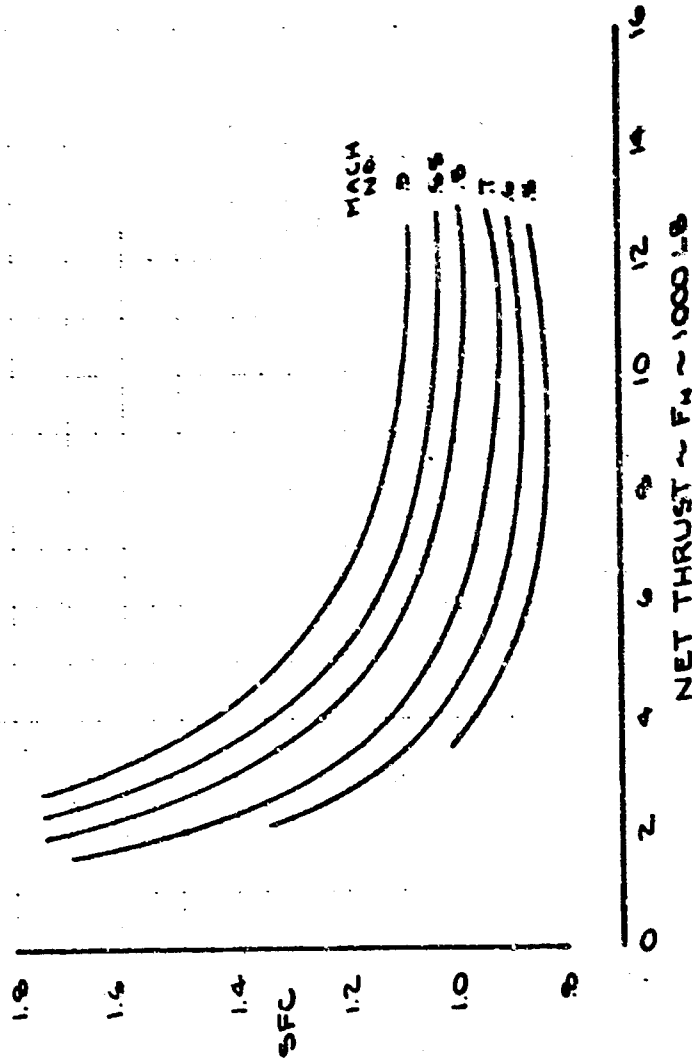


Fig. 13 SFC versus Thrust - Standard Day, 25,000 Ft.

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JTF 17A-20B-1500F/2000°F RATING

STANDARD DAY
36,150 FT

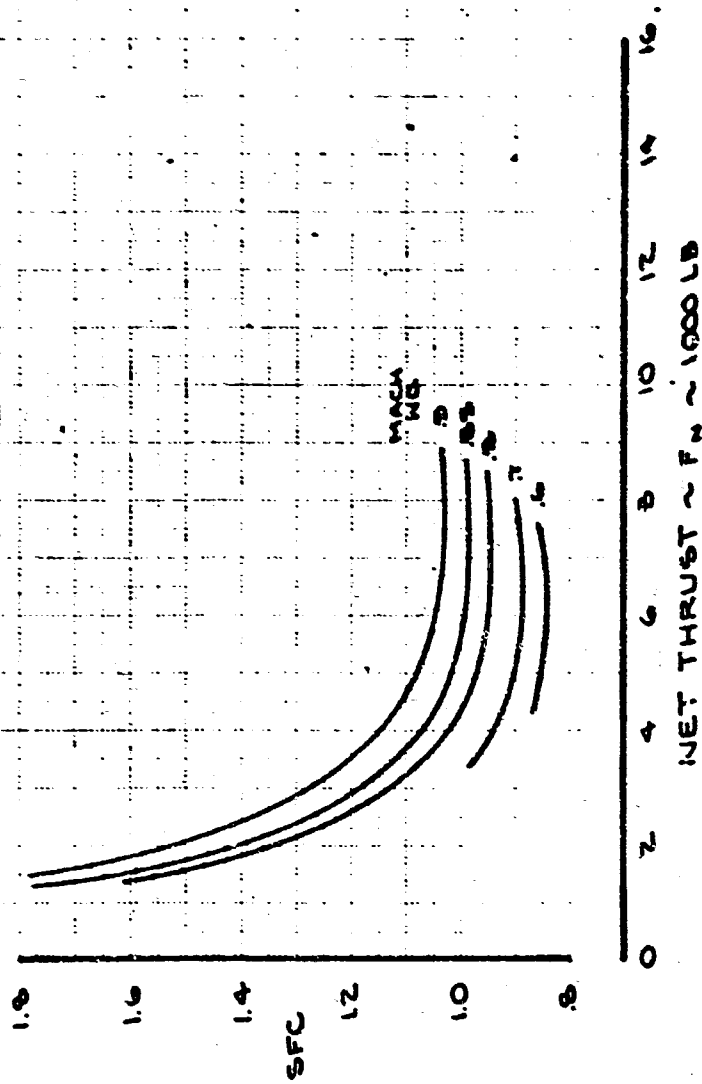


Fig. 14 SFC versus Thrust - Standard Day, 36,150 Ft.

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JTF 17A - 2.0B-1500°F / 2000°F RATING

STANDARD DAY
45000 FT.

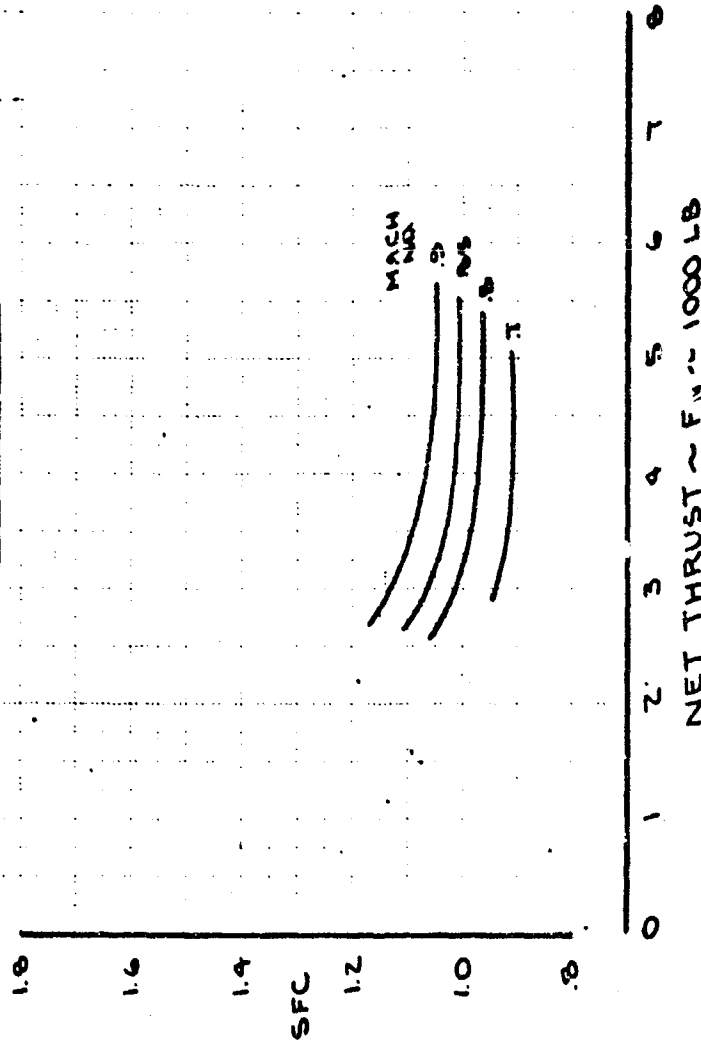


Fig. 15 SFC versus Thrust - Standard Day, 45,000 Ft.

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JTF17A-20B ~ 1900°F / 2000°F RATING

STANDARD DAY
IDLE POWER

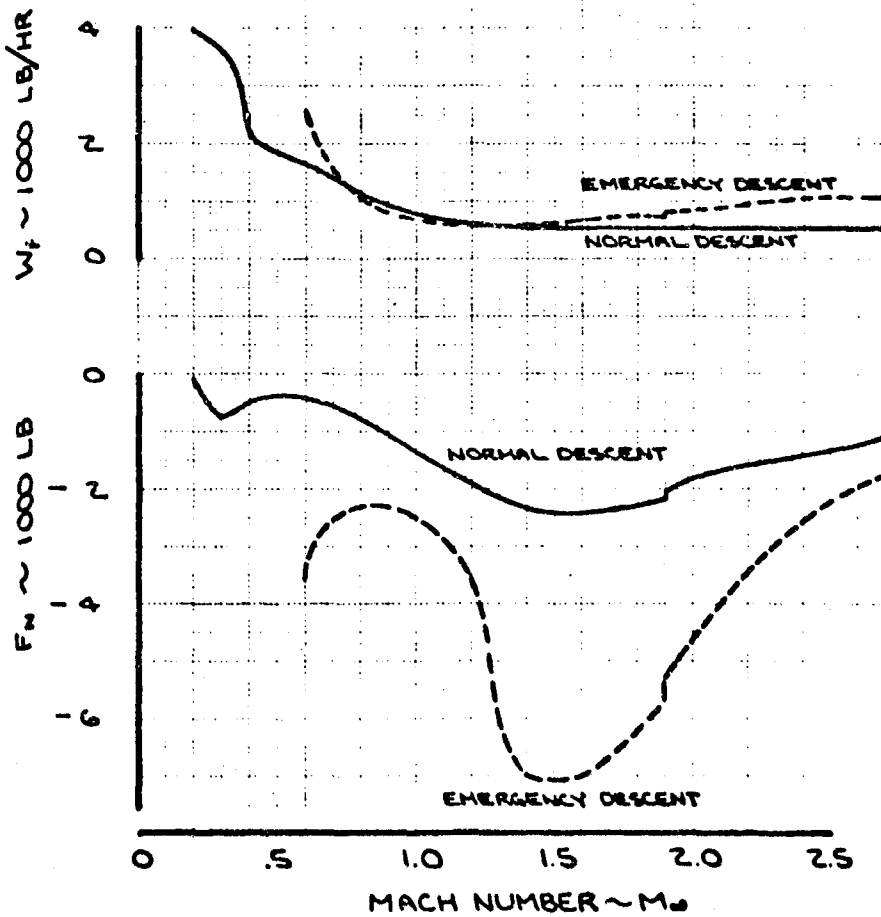
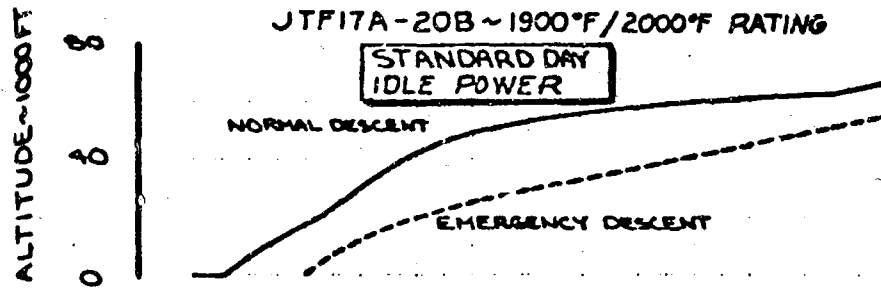


Fig. 16 Normal and Emergency Descent - Thrust and Fuel Flow - Standard Day

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5.0 PROPULSION SYSTEM DRAG

5.1 INLET DRAG

Inlet drag is included in the airplane drag build-up for airplane performance calculations. The inlet drag includes spillage, cowl suction, bypass momentum, bypass louver, boundary layer bleed, and aircraft air-conditioning bleed drags. Table A lists the airbleed extracted from the inlet for various flight conditions to supply high-pressure air for air conditioning.

Fig. 1 shows the inlet drag for maximum dry and augmented power settings during standard and hot-day operation. The excess air drag at partial power when engine airflow demand is reduced is also shown on Fig. 1.

The inlet drag during normal and emergency descent operation at idle power settings is shown in Fig. 17.

5.2 NOZZLE DRAG

No correction to airplane drag is made for nozzle external drag because this drag is included in the nozzle thrust coefficient.

JTF 17A-20B - 1900T / 2000°F RATING

STANDARD DAY
IDLE POWER

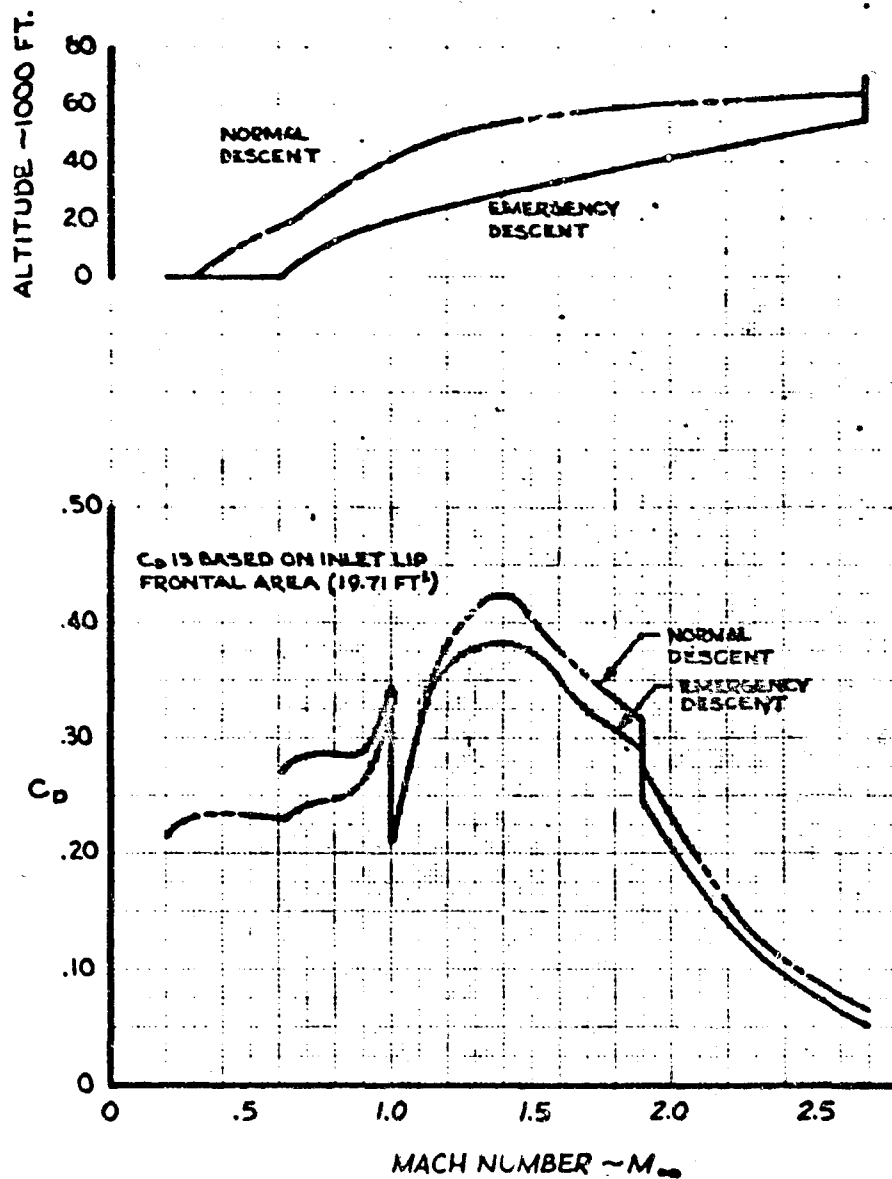


Fig. 17 Installed Inlet Drag Coefficients - Idle Descent

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APPENDIX

JTF17A-20B 2200°F/2300°F

The appendix (Figs. A-1 through A-12) presents the installed engine performance data for the "basic" FWA JTF17A-20B turbofan engine rated at 2200°F cruise turbine-in-temperature.

The airflow schedule and inlet drags for this engine are the same as for the 1900°F engine.

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JTF 17A-208 ~ 2200°F / 2300°F RATING

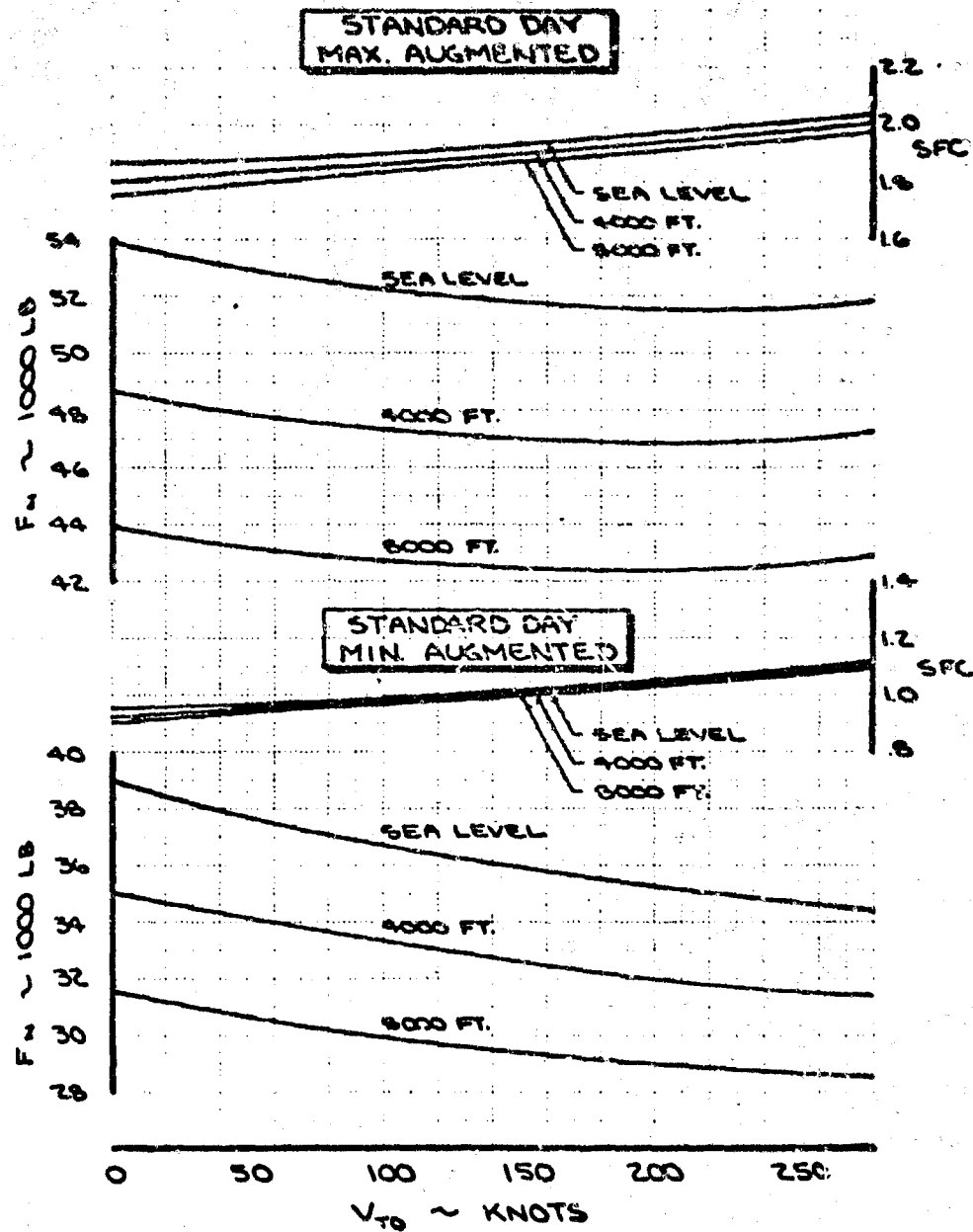


Fig. A-1 Takeoff Net Thrust and SFC - Standard Day

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JTF 17A-ZOB ~ 2,200°F/2,300°F RATING

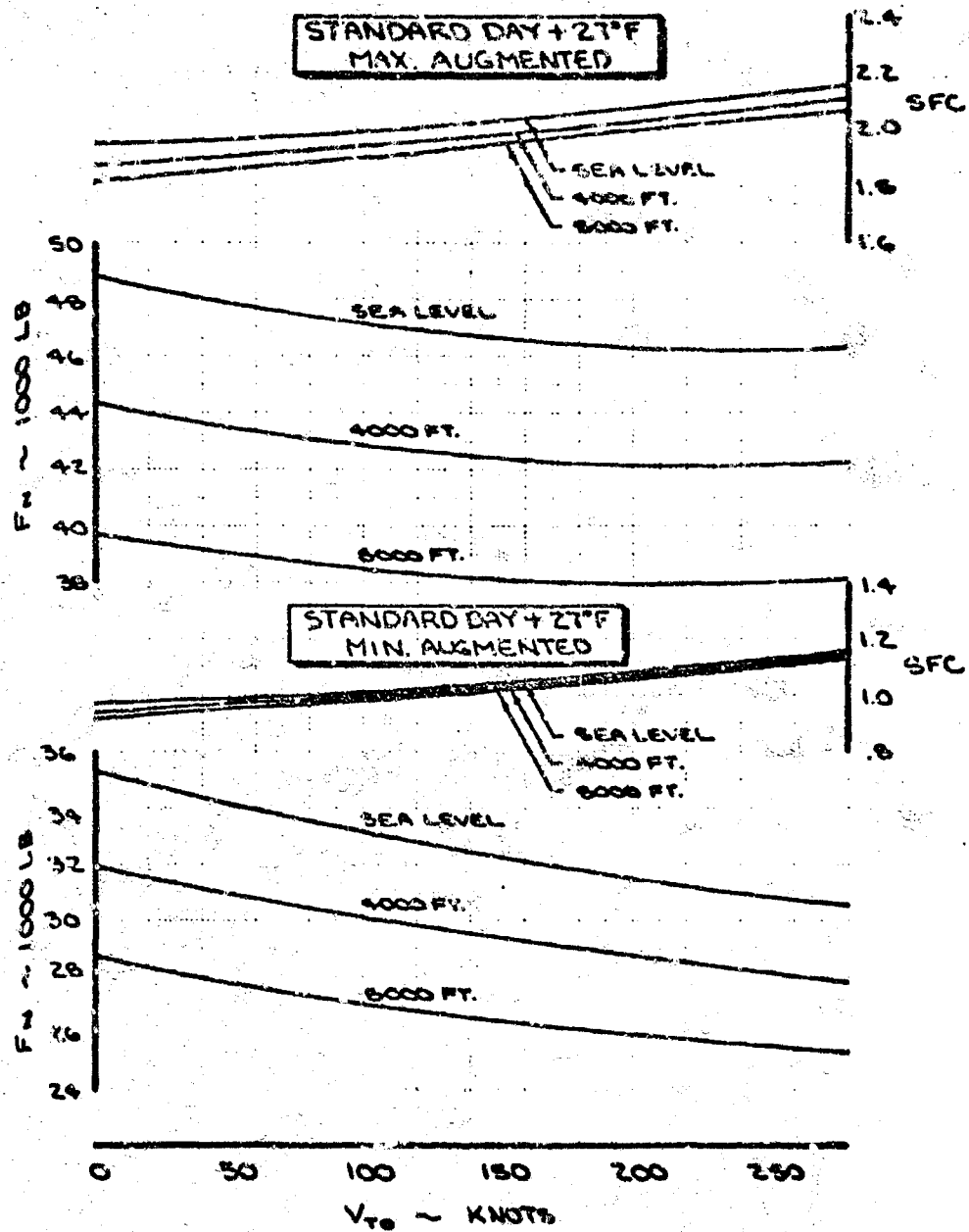


Fig. A-2 Takeoff Net Thrust and SFC - Standard Day + 27°F

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JTF 17A-208 ~ 2200°F / 2300°F RATING

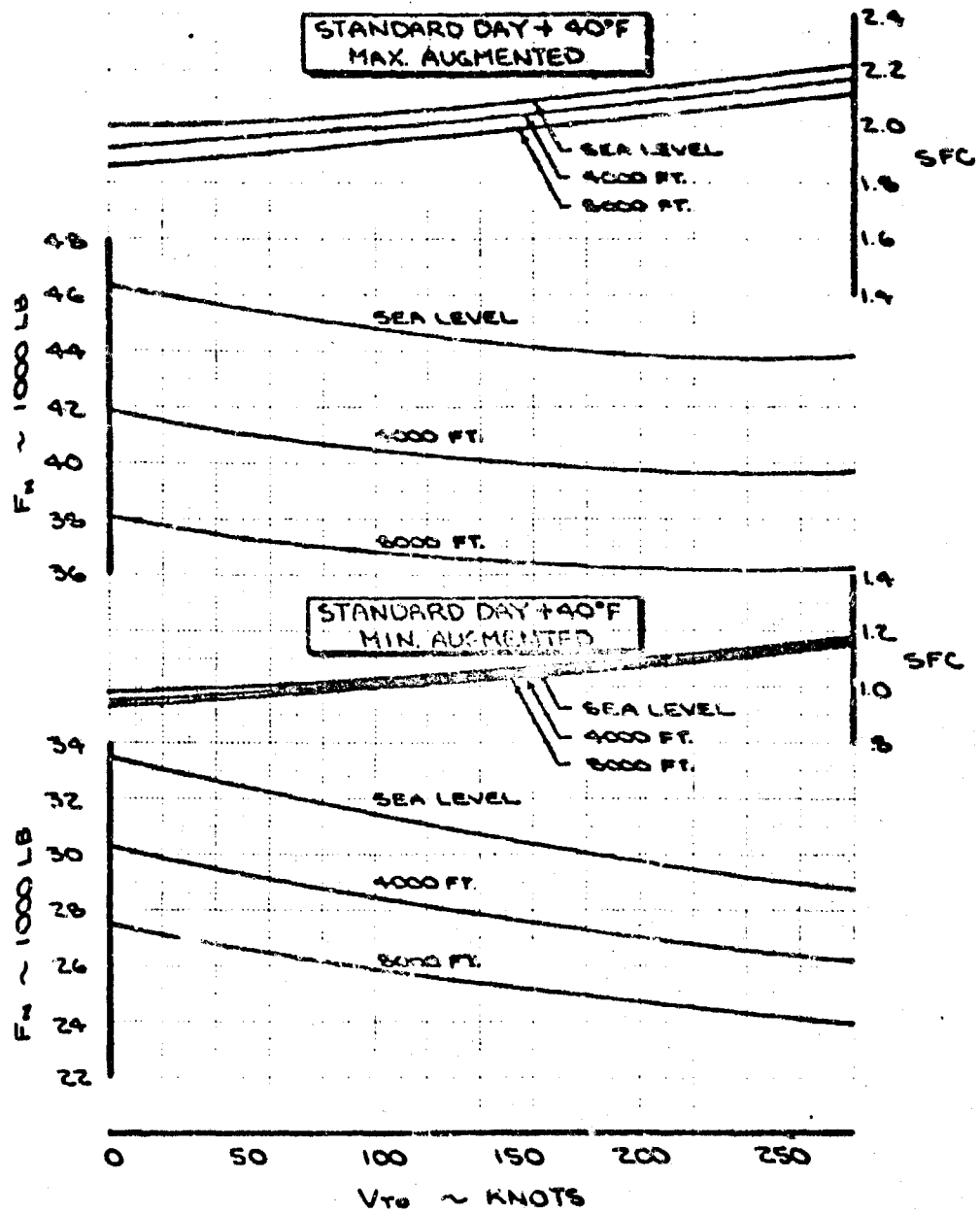


Fig. A-3 Takeoff Net Thrust and SFC - Standard Day + 40°F

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JTF 17A-208-22W/F/2300°F RATING

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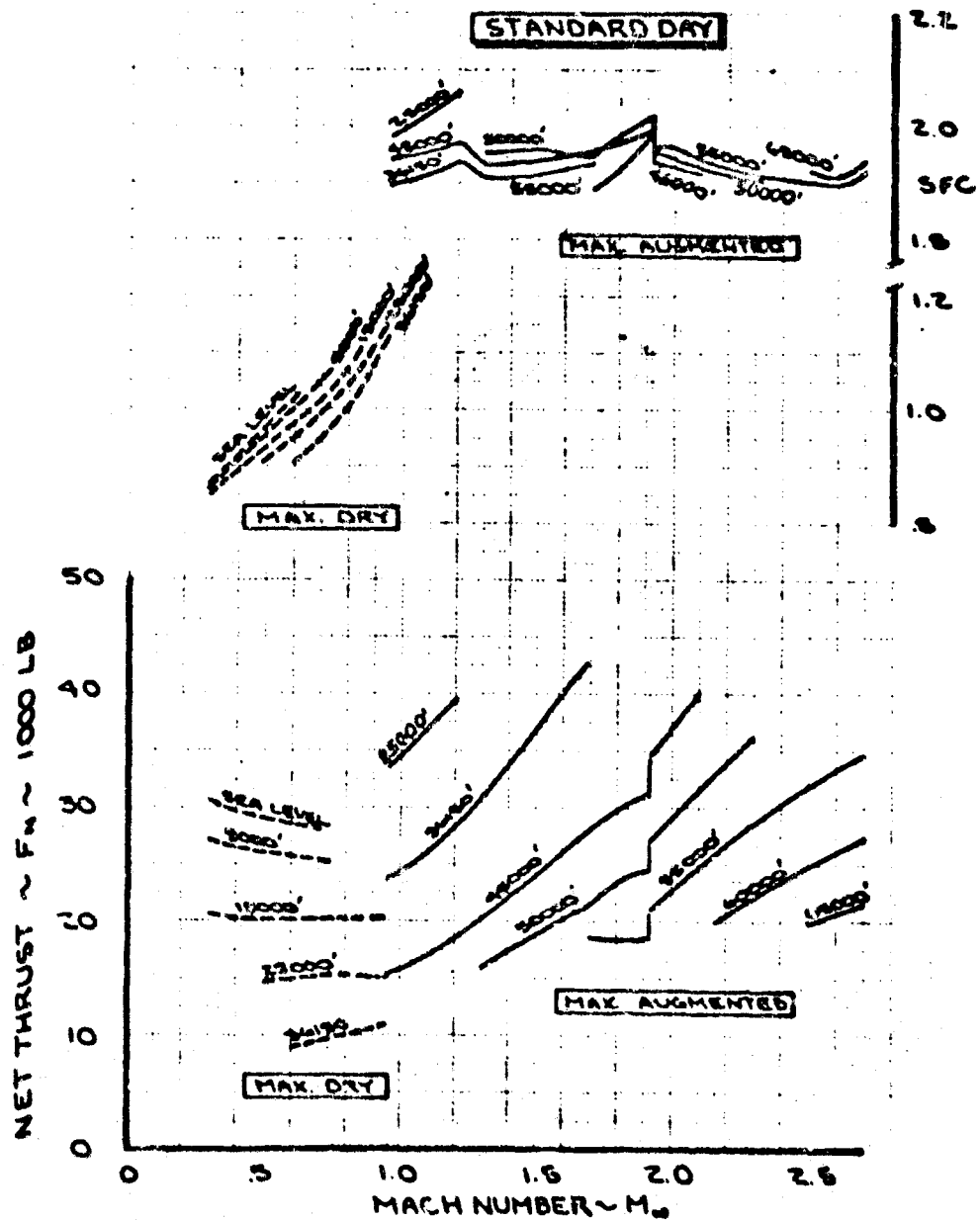


Fig. A-4 Climb and Acceleration Net Thrust and SFC - Standard Day

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JTF 17A-208 -- 2200°F / 2300°F RATING

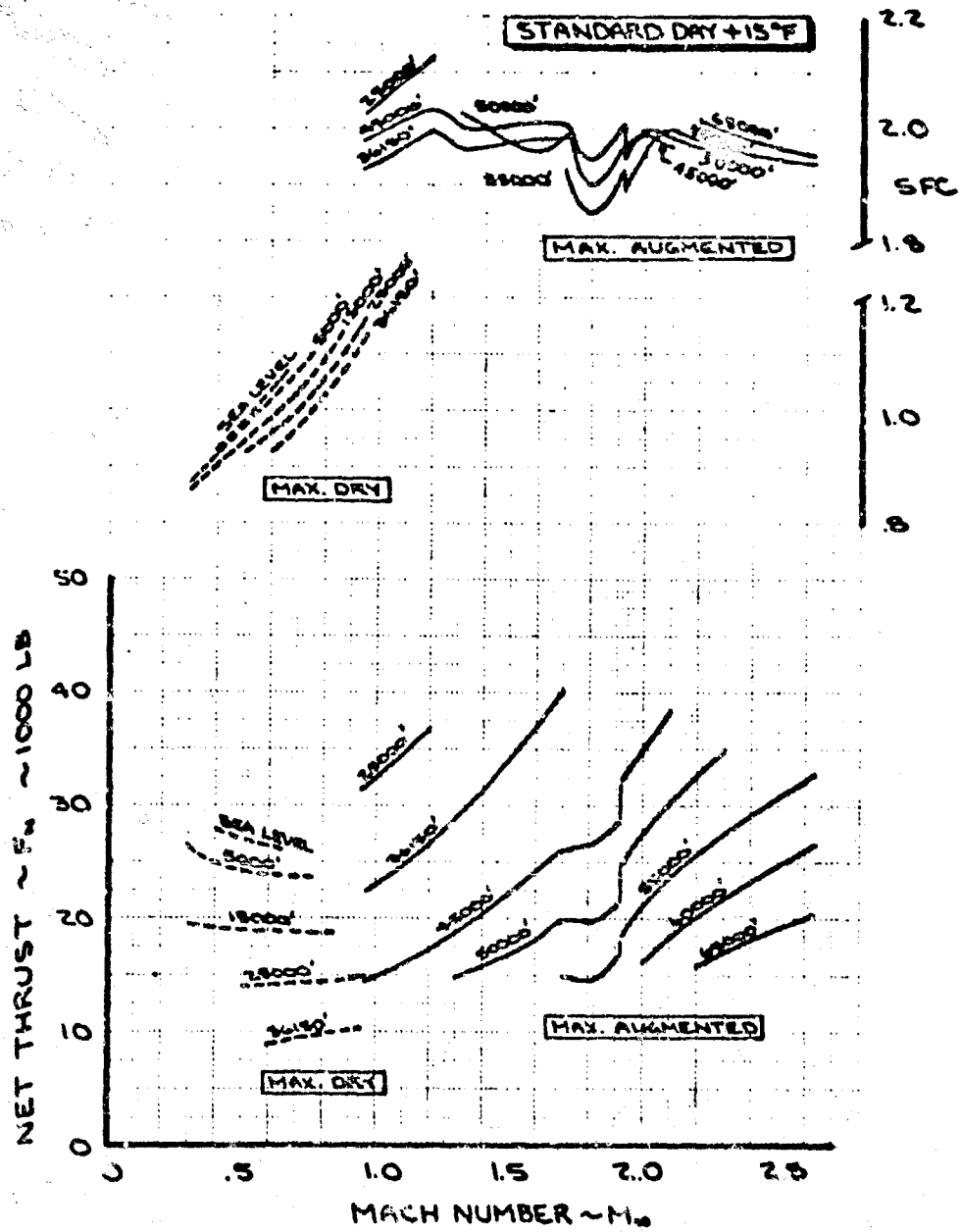


Fig. A-5 Climb and Acceleration Net Thrust and SFC - Standard Day + 15°F

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JTF 17A-20B ~ 2200°F/2300°F RATING

MACH 2.7 CRUISE
STANDARD DAY
T₂ LIMIT = 500°F

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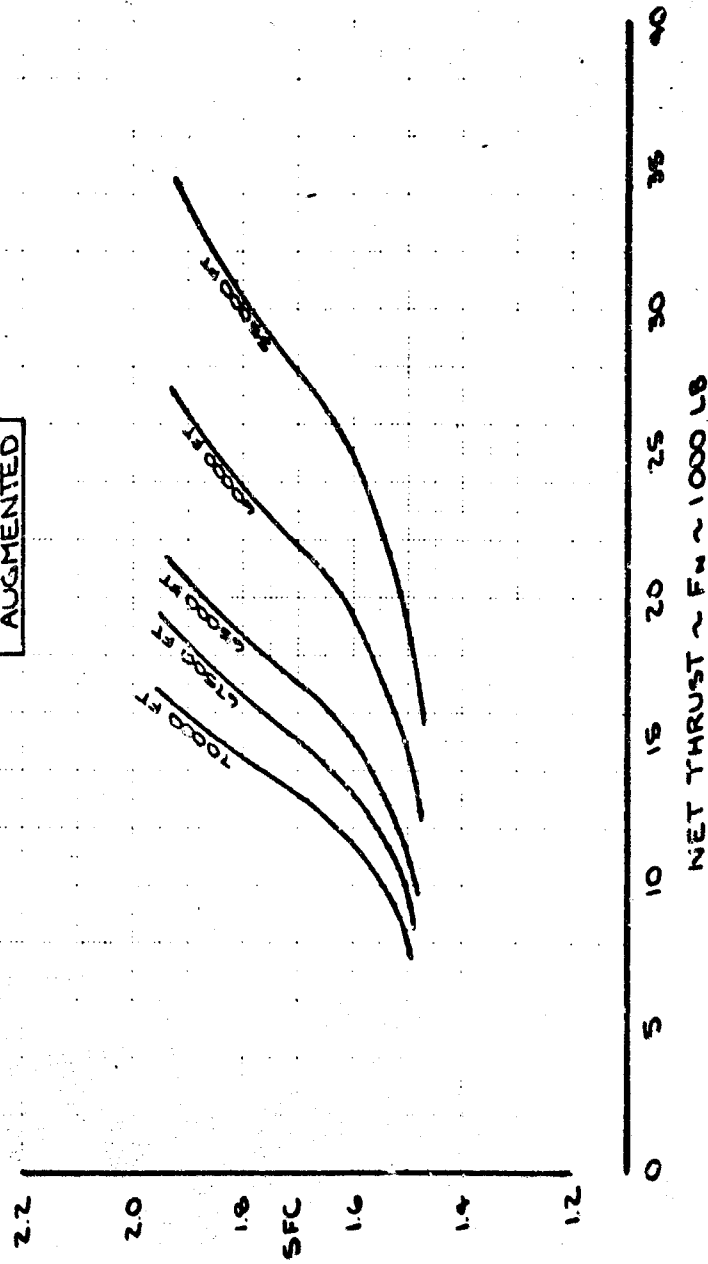


Fig. A-6 Cruise Net Thrust and SFC - Standard Day

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JTF 17A-20B ~ 2200°F / 2300°F RATING

MACH 2.63 CRUISE
STANDARD DAY + 15°F
T₂ LIMIT = 500°F

AUGMENTED

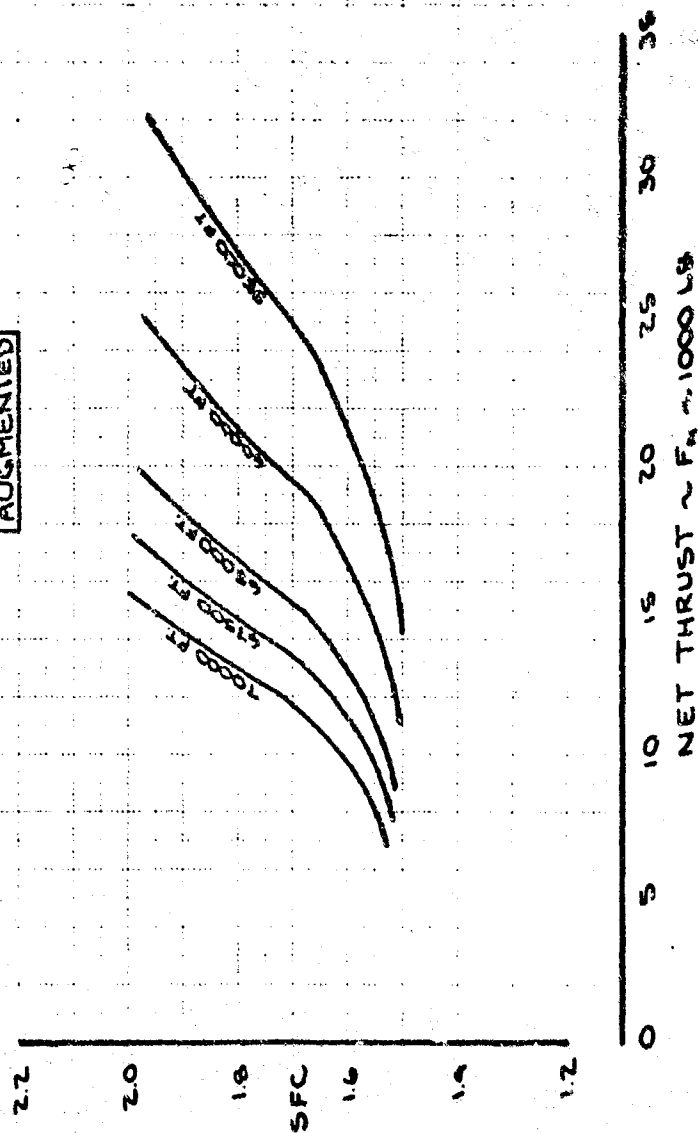


Fig. A-7 Cruise Net Thrust and SFC - Standard Day + 15°F

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JTF 17A - ZOB ~ 2200°F / 2300°F RATING

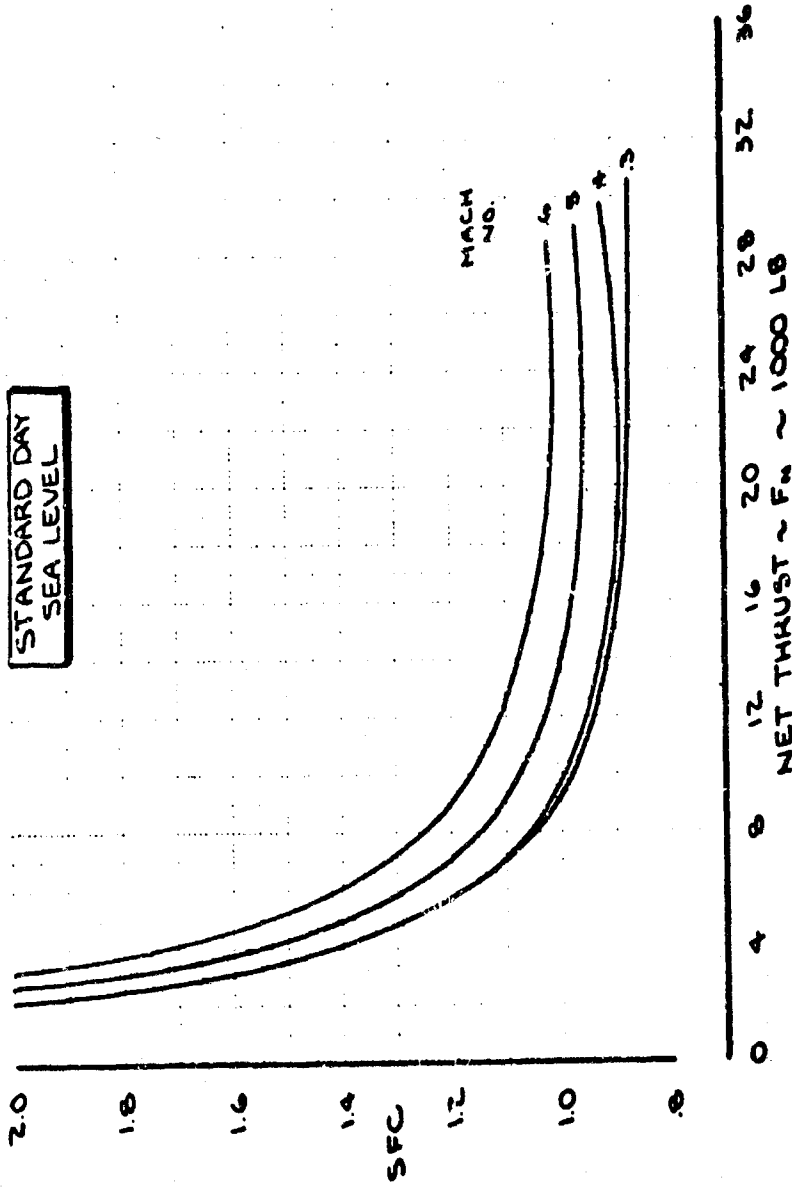


Fig. A-8 SFC versus Thrust Standard Day, Sea Level

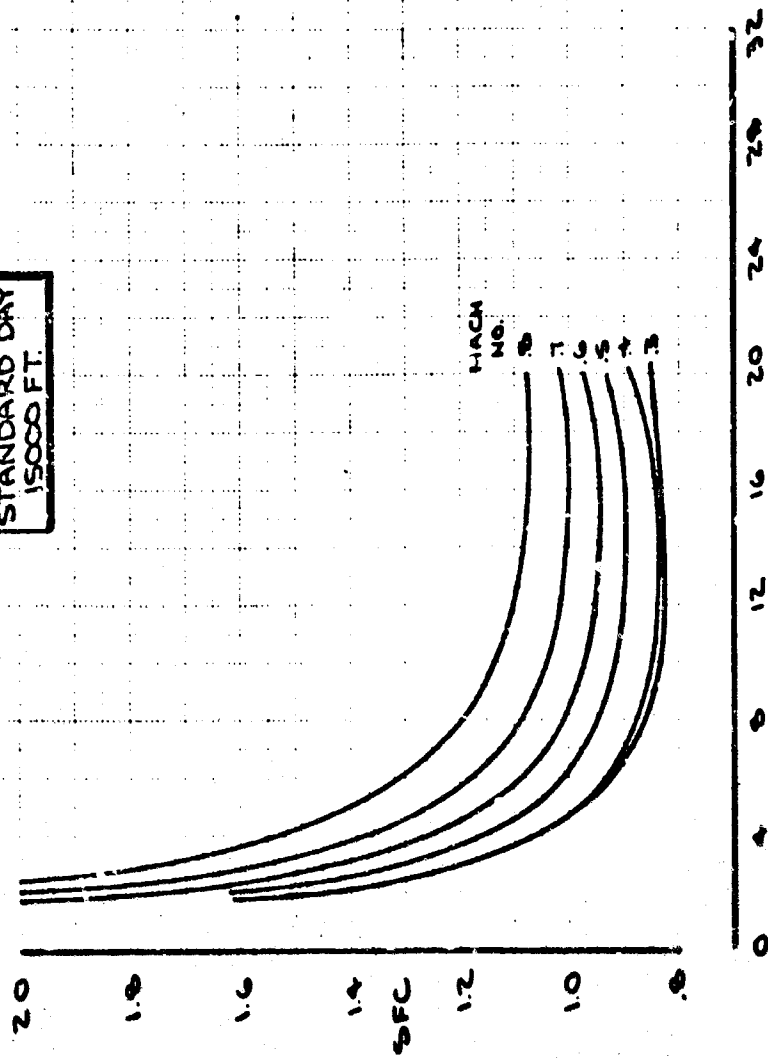
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JTF 17A-208 ~ 2200°F/2300°F RATING

STANDARD DAY
15000 FT.



NET THRUST ~ F_n ~ 1000 LB

Fig. A-9 SFC versus Thrust Standard Day, 15,000 ft.

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JTF 17A-20B ~ 2200°F / 2300°F RATINGS

STANDARD DAY
25000 FT.

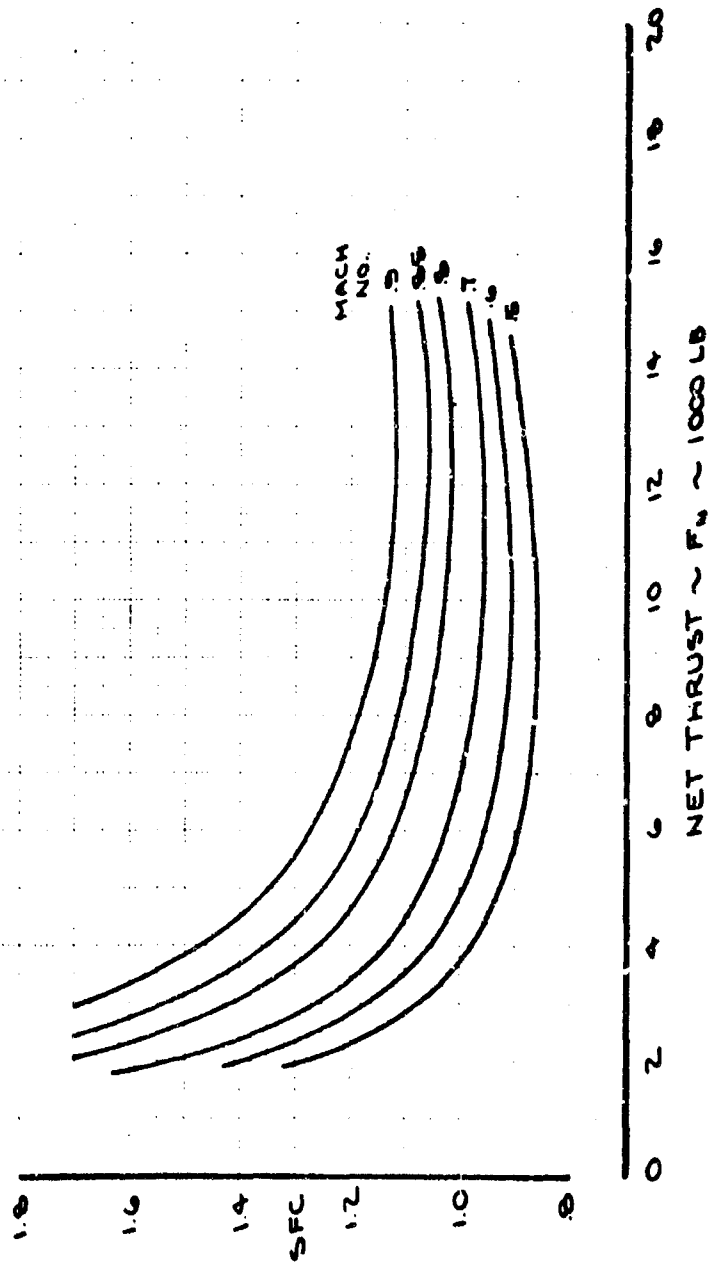


Fig. A-10 SFC versus Thrust Standard Day, 25,000 ft.

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JTF 17A-20B ~ 2200°F/2300°F RATING

STANDARD DAY
36,150 FT.

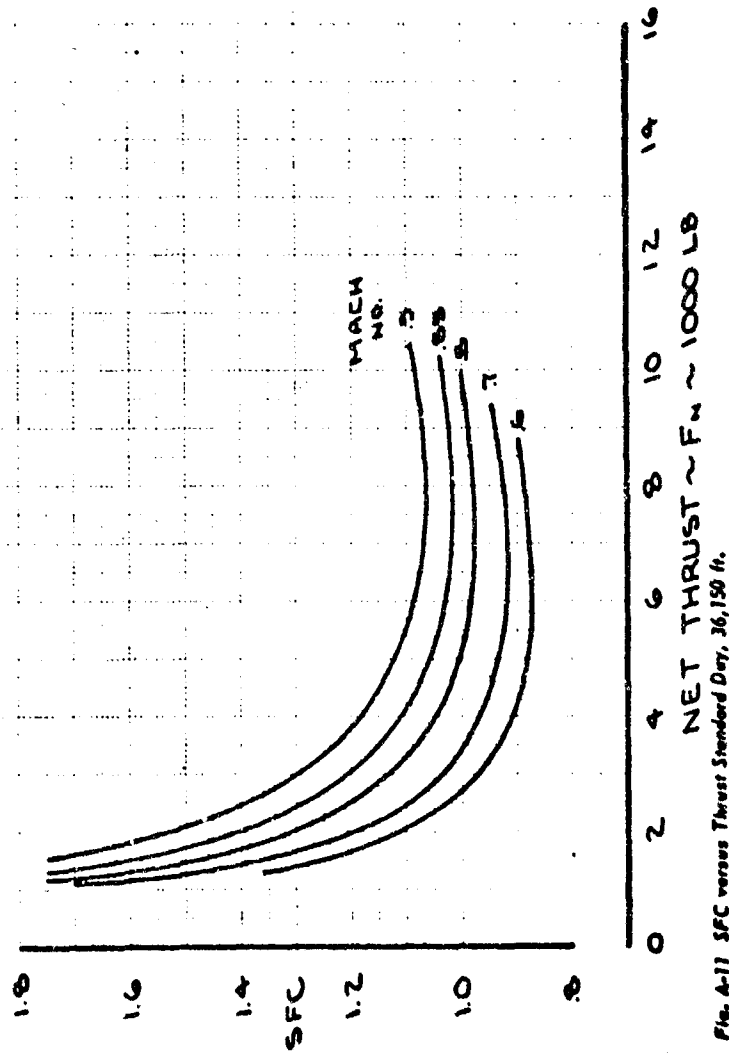


Fig. A-11 SFC versus Thrust Standard Day, 36,150 ft.

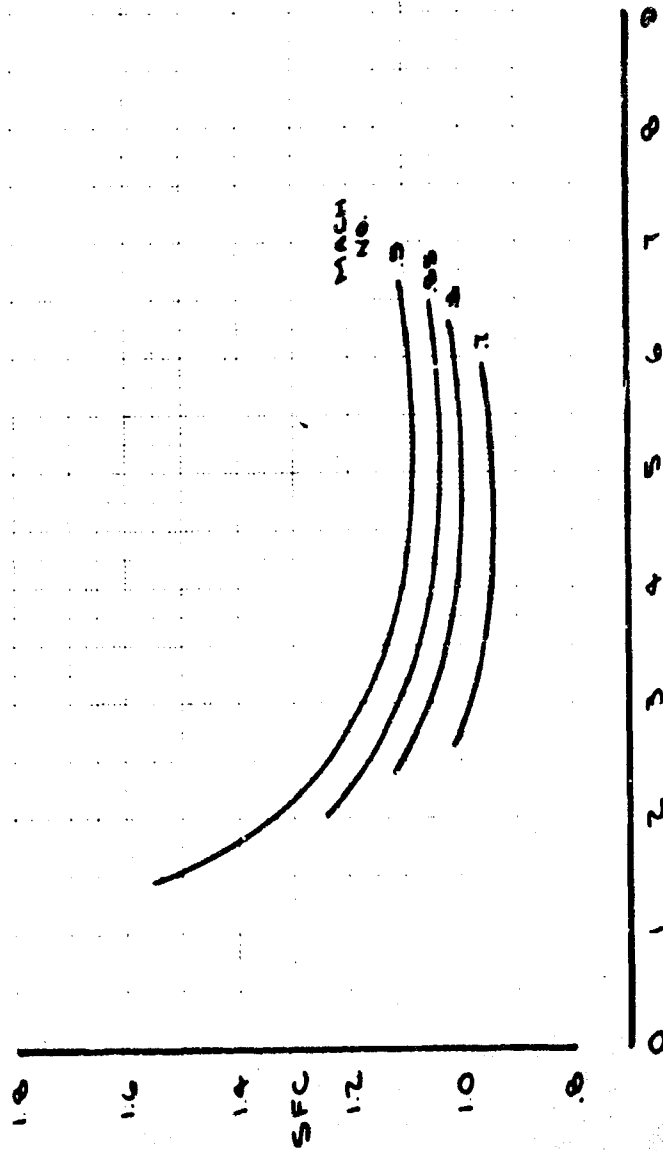
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JTF 17A-20B ~ 2200°F/2300°F RATING

STANDARD DAY
45000 FT



NET THRUST ~ F_N ~ 1000 LB

Fig. 4-12 SFC versus Thrust Standard Day, 45,000 ft.

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